REMARKS

This paper is responsive to an Office Action dated April 17, 2002. Prior to this amendment claims 1-23 were pending. After amendments to claims 2, 4-6, 9, 15, 17-19, and 22, claims 1-23 remain pending.

In Section 1 of the Office Action, the specification has been objected to on pages 3 and 8-13 for the use of the phrases "percentage by atomic weight" and "atomic weight per cubic centimeter". In response, the above-mentioned phrases have been replaced with the phrases "atomic percent" and "atoms/cm^3", respectively.

In Section 2 of the Office Action, claims 4-6, 17-19, and 22 have been rejected for the use of the phrases mentioned above in the response to Section 1 of the Office Action. Claims 4-6, 9, 17-19, and 22 have been amended to replace these phrases.

In Section 4 of the Office Action, claims 1-3, 12, and 14 have been rejected under 35 U.S.C. 102(b) as being anticipated by Zhang (US Patent 5,569,936). The Office Action states that Zhang teaches a method for forming an LCD device by sputter depositing with a silicon target including a transition metal impurity. This rejection is traversed as follows.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Zhang, in a single line in the Summary (col. 3, ln. 62-65), mentions that when amorphous silicon is formed by sputtering, a catalyst can be added in the target material. In the detailed description of the preferred embodiments Zhang specifically describes four production process embodiments. However, none of these embodiments mention the use of a silicon target, embedded with

impurities, to form a silicon film. In the first embodiment (col. 6, ln. 10-11), second embodiment (col. 7, ln. 18-20), third embodiment (col. 8, ln. 41-42), and fourth embodiment (col. 10, ln. 2-4), amorphous silicon is deposited using a CVD process. In short, Zhang does not enable one skilled in the art to use a silicon target including impurities to form a silicon layer as the claimed invention recites in claim 1.

More specifically, the invention of claim 1 states that the target has a first concentration of a first impurity, and that the resultant silicon film includes a second concentration of the first impurity. Alternately stated, the invention of claim 12 recites the sputter deposition of a controlled amount of impurities. Zhang does not teach the use of a particular concentration of impurities in the target, selected to achieve the desired concentration of impurities in the resultant silicon film. Zhang does not describe the concentration of impurities required in the silicon target. Therefore, Zhang does not teach all the elements of the invention of claims 1 and 12, and cannot anticipate the claimed invention. Claims 2, 3, dependent from claim 1, and claim 14, dependent from claim 12, also benefit from the above-mentioned distinctions between the prior art reference and the claimed invention.

In Section 6 of the Office Action, claims 4, 5, 11, 13, 15, and 16-18 have been rejected as obvious under 35 U.S.C. 103(a) with respect to Zhang. The Examiner acknowledges that Zhang fails to teach the use of a single crystal silicon and a first Ni concentration of 0.01 to 0.5 at%, to form amorphous Si with a second concentration of Ni. The Office Action states, however, that it would have been obvious to one skilled in the art to form an amorphous silicon film with a second concentration of Ni using a single crystal target with a first concentration of Ni. This rejection is traversed as follows.

An invention is unpatentable if the differences between it and the prior art would have been obvious at the time of the invention. As stated in

MPEP § 2143, there are three requirements to establish a *prima facie* case of obviousness.

> First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.

Generally, as mentioned above, Zhang teaches a process (or four processes) that involve the CVD deposition of amorphous silicon film. Only in one line is the possibility of using a target to sputter deposit amorphous silicon even mentioned. Although the Office Action states that it would have been obvious for one skilled in the art to "form amorphous film with a second Ni concentration from a composite target of single crystal silicon and a first Ni concentration of 0.01 – 0.5 atom%....", there is no suggestion in Zhang that any particular concentration of Ni be used to form targets. That is, Zhang does not describe any details sufficient to enable one to build a target with the first concentration of Ni.

"Any judgment on obviousness is in a sense necessarily a reconstruction based on hindsight reasoning, but as long as it takes into account only knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made and does not include knowledge gleaned from applicant's disclosure, such as reconstruction is proper." *In re McLaughlin* 443 F.2d 1392, 1395, 170 USPQ 209, 212 (CCPA 1971). There is no evidence in the Zhang reference that a target having a Ni concentration of 0.01 to 0.5 at% was known. The Applicant respectfully submits that the cited prior art is only

modified in retrospect, in light of the present invention. That is, the obviousness rejection is based upon the Applicant's own invention characterization, not the modification of Zhang.

Further, the Examiner has not demonstrated that the modification of the cited the prior art reference points to the reasonable expectation of success in the present invention, which is the second requirement of the obviousness analysis.

With respect to the third requirement to support a *prima facie* case of obviousness, as noted in the response to the anticipation rejection, Zhang does not describe all the elements of either claim 1 or 12. That is, Zhang does not teach the use of a particular concentration of impurities in the target, selected to achieve the desired concentration of impurities in the resultant silicon film. Zhang does not describe the concentration of impurities required in the silicon target. Since Zhang neither suggests, nor teaches all the elements of the claimed invention, the Examiner is requested to withdraw the rejection.

In Section 7 of the Office Action, claims 6, 8, 9, 19, 21, and 22 have been rejected under 35 U.S.C. 103(a) as obvious with respect to Zhang, in view of Yamazaki (US Patent 6,306,694). The Examiner acknowledges that Zhang fails to disclose the use of a third concentration of P in the target, and a fourth concentration of P in the deposited film sufficient to create a Vth shift. The Examiner also acknowledges that Zhang fails to teach a first concentration of Ge in the target to form a Si film with a second concentration of Ge and a fourth concentration of P. The Office Action states that Yamazaki teaches the use of Ge as a crystallization catalyst and the use of dopants to control threshold voltages, and that it would have been obvious to combine the two references so as to make the claimed invention obvious. This rejection is traversed as follows.

Yamazaki describes several processes for forming TFTs suitable for use in an active matrix LCD. The first embodiment describes the deposition of

amorphous silicon film "by a known deposition method" and mention is made of a silicon germanium film (col. 7, ln. 24-30). The second embodiment begins at Fig. 4, well after the deposition of amorphous silicon (col. 17, ln. 60-63). Likewise, the third embodiment begins at Fig. 7, at a higher process level (col. 18, ln. 33-34). Embodiment 4 is the same as the first embodiment (col. 19, ln. 33-35), except for the formation of film 104 (col. 19, ln. 40-43), a step that occurs after the deposition of amorphous silicon. Likewise, the fifth embodiment is the same as the first embodiment, and describes differences that occur after the deposition of amorphous silicon (col. 20, ln. 4-9). Embodiment 6 deals with modifications in the laser annealing step (col. 20, ln. 48-51). Embodiments 7 and 8 describe the formation of a protective film overlying the crystallized silicon (col. 21, ln. 19-22 and col. 22, ln. 7-10). Embodiment 9 is similar to embodiment 7 (col. 22, ln. 53-55). Embodiment 11 mentions a CVD process to deposit amorphous silicon (col. 23, ln. 41-44).

In summary, there are a total of 47 embodiments described by Yamazaki. However, none of the embodiments describe an amorphous silicon deposition process that differs from the first embodiment, and the first embodiment just describes deposition by a known technique. More specifically, Yamazaki does not describe an amorphous silicon sputtering process, or the use of target impurities to form an amorphous silicon film with impurities. When Yamazaki adds impurities, they are always added in a process performed subsequent to the deposition of the amorphous silicon film. For example, in embodiment 25 a catalytic agent is added in an aqueous solution over the surface of the amorphous silicon (col. 32, ln. 23-31). Likewise, the addition of dopants to specific areas of a subsequently formed transistor are described (col. 4, ln. 13-33). The sputter deposition of an amorphous silicon film including impurities is not described.

There appears to be no motivation to combine the Zhang and Yamazaki references. "Therefore, an examiner may often find every element of a claimed invention in the prior art. If identification of each claimed element in the prior art were sufficient to negate patentability, very few patents would ever issue....To prevent the use of hindsight based on the invention to defeat patentability of the invention, this court requires the examiner to show a motivation to combine the references that would create the case of obviousness. In other words, the examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art reference for combination in the manner claimed." *In re Rouffet*, 47 USPQ2d 1453, 1457-1458 (1998).

Further, even if the references could be combined, there is nothing in the Yamazaki disclosure to suggest a modification of Zhang in a way makes the claimed invention of either claim 1 or claim 12 obvious. That is, there is no suggestion in Yamazaki to form a target with a first concentration of impurities necessary to form a second concentration of impurities in a deposited silicon film. Neither has the Examiner demonstrated that the modification of the combined prior art references point to the reasonable expectation of success in the present invention, which is the second requirement of the obviousness analysis.

The third requirement to support a *prima facie* case of obviousness requires that the combined references disclose all the elements of the claimed invention. However, the convention amorphous silicon deposition processes of Yamazaki, when combined with Zhang still does not teach the use of a particular concentration of impurities in the target, selected to achieve the desired concentration of impurities in the resultant silicon film, or describe the concentration of impurities required in the silicon target. Claims 6, 8, 9,

dependent from claim 1, and claims 21 and 22, dependent from claim 12, also benefit from the above-mentioned distinctions. Since the cited prior art neither suggests, nor contains all the elements of the claimed invention, the Examiner is requested to withdraw the rejection.

In Section 8 of the Office Action, claims 7, 10, 20, and 23 have been rejected under 35 U.S.C. 103(a) as obvious with respect to Zhang, in view of Yamazaki and the APA (US Patent 6,149,784, Su). The Examiner acknowledges that neither Zhang nor Yamazaki teach DC sputtering, but that the combination of the DC sputtering process described by Su, combined with Zhang and Yamazaki make the claimed invention obvious. This rejection is traversed as follows.

Su describes the use of a shield that can be added to a DC magnetron sputtering reactor to protect the chamber walls from being coated with sputtering material (col. 3, ln. 45-49). Su does not describe the use of silicon targets made with particular concentrations of impurities, or specifics of an amorphous silicon deposition processes. Applicant is providing a copy of Su for the Examiner's convenience.

Again there appears to be no motivation to combine the three references. "The mere fact that references <u>can</u> be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Neither has it been demonstrated that the modification of the combined prior art references point to the reasonable expectation of success in the present invention, which is the second requirement of the obviousness analysis.

The third requirement to support a *prima facie* case of obviousness requires that the combined references disclose all the elements of the claimed invention. However, the DC sputtering process of Su, combined with the

convention amorphous silicon deposition processes of Yamazaki and Zhang, still does not teach the use of a particular concentration of impurities in the target, selected to achieve the desired concentration of impurities in the resultant silicon film, or describe the concentration of impurities required in the silicon target. Claims 7 and 10, dependent from claim 1, and claims 20 and 23, dependent from claim 12, also benefit from the above-mentioned distinctions. Since the cited prior art neither suggests, nor contains all the elements of the claimed invention, the Examiner is requested to withdraw the rejection.

It is believed that the application is in condition for allowance and reconsideration is earnestly solicited.

Respectfully submitted,

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The following pages are a version of the specification and claim amendments with Markings to show the changes made to pages 3 and 8-13 of the specification, and claims 2, 4-6, 9, 15, 17-19, and 22.

On page 3, from lines 10 through 26:

Forming a target including silicon and a first concentration of a first impurity includes using a first impurity selected from the group including [transistion] <u>transition</u> metals, phosphorous, and germanium. When the first impurity is Ni, the first concentration of nickel in the target is in the range of 0.01 to 0.5 <u>atomic</u> percent[age by atomic weight] (at %). Preferably the range is 0.05 to 0.2 at %. Then, the second concentration of Ni in the depositing a silicon film is in the range of 0.01 to 0.5 at %.

When the first impurity is germanium, the first concentration of germanium in the target is in the range of 5 to 30 at %, and the second concentration of germanium in the deposited silicon film is in the range of 5 to 30 at %.

Phosphorous can be added as an additional impurity, with either nickel or germanium. The concentration of phosphorous in the target is less than 5 x e^{17} <u>atoms</u> [atomic weight] per cubic centimeter (<u>atoms</u> [at]/cm^3). As a result, the concentration of phosphorous in the deposited silicon film is sufficient to create a Vth shift.

On page 8, lines 5 through 15:

The Ni-doping level in the silicon target depends upon the Ni-doping requirement in the as-sputtered Si film. For effective silicide-assisted crystallization, a Ni concentration of 0.01 at% to 0.5 at% [(atomic weight %)] is required in the silicon film. This implies that this concentration range of Ni in the Si target should be in a similar range. However, there are differences in the sputtering yield between Ni and Si atoms. Ni has a 2-3 times higher yield than Si. Therefore, it may be concluded that a lower

concentration range of Ni in the Si target yields the required concentration range in the sputtered film. The concentration range of Ni in the silicon target is then in the range of 0.05 at % to 0.2 at %.

On page 9, lines 8 through 15:

Further, the Si target can be doped with P (phosphorous), in additional to doping the target with Ni or Ge. The P addition, permits the formation of lightly p-type poly-Si film. This light doping is beneficial for threshold voltage adjustment of thin film transistors (TFTs) fabricated from such poly-Si films. The level of P doping is determined based upon the magnitude of the Vth shift. Generally, the P concentration in the Si(Ni) or Si(Ge) target should be less than 5e17 <u>atoms</u>[at]/cm³, or less than 10ppm.

On page 10, line 9, through page 11, line 3:

In some aspects of the invention, the first impurity is the [transistion] <u>transition</u> metal nickel. Then, forming a target including silicon and a first concentration of a first impurity in Step 302 includes forming a target with a first concentration of nickel in the range of 0.01 to 0.5 [percentage by atomic weight (at %)]. Sputter depositing a film of silicon on the substrate including a second concentration of the first impurity in Step 306 includes depositing a silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %. However, because of the differences in yield between Si and Ni, Step 302 preferably forms a target with a first concentration of nickel in the range of 0.05 to 0.2 [percentage by atomic

weight ()at %()], while Step 306 deposits a silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %.

In some aspects of the invention, Step 302 forms a target including silicon, a first concentration of a nickel, and an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3()]. Sputter depositing a film of silicon on the substrate including a second concentration of nickel in Step 306 includes depositing a silicon film with an additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.

On page 11, from lines 15 through 22:

In some aspects, Step 302 forms a target including silicon, a first concentration of a germanium, and an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3()]. Sputter depositing a film of silicon on the substrate including a second concentration of germanium in Step 306 includes depositing a silicon film with an additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.

On page 12, from line 14, through page 13, line 15:

When Step 404 forms a target with a first concentration of nickel in the range of 0.01 to 0.5 [percentage by atomic weight ()at %()], Step 408 forming an amorphous silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %. Preferably, the first concentration of

Ni in the target is in the range of 0.05 to 0.2 [percentage by atomic weight (]at %[)].

In some aspects of the invention, forming a target of single-crystal silicon in Step 404 includes adding a first concentration of nickel with a third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3[)]. Then, Step 408 forms a silicon film including a second concentration of nickel and a fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film. The definition of the first Vth shift is dependent upon the desired threshold adjustment of the final product TFT.

Step 410 anneals the silicon film including the nickel first impurity to form a nickel silicide. Step 412 anneals the silicon film with the nickel silicide to crystallize the silicon film.

When Step 404 forms a target of single-crystal silicon with a first concentration of germanium in the range of 5 to 30 at %, Step 408 forms an amorphous silicon film including a second concentration of germanium in the range of 5 to 30 at %. If Step 404 forms a target of single-crystal silicon including a first concentration of germanium and an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3[)], Step 408 forms an amorphous silicon film including a second concentration of germanium and an additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.

2. (Amended) The method of claim 1 wherein forming a target including silicon and a first concentration of a first impurity includes forming a target with a first impurity selected from the group including [transistion] <u>transition</u> metals, phosphorous, and germanium.

4. (Amended) The method of claim 3 wherein forming a target including silicon and a first concentration of a first impurity includes forming a target with a first concentration of nickel in the range of 0.01 to 0.5 [percentage by] atomic <u>percent</u> [weight] (at %); and,

wherein sputter depositing a film of silicon on the substrate including a second concentration of the first impurity includes depositing a silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %.

5. (Amended) The method of claim 4 wherein forming a target including silicon and a first concentration of a first impurity includes forming a target with a first concentration of nickel in the range of 0.05 to 0.2 [percentage by atomic weight (]at %[)]; and,

wherein sputter depositing a film of silicon on the substrate including a second concentration of the first impurity includes depositing a silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %.

6. (Amended) The method of claim 4 wherein forming a target including silicon and a first concentration of a nickel includes forming the target with an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] <u>atoms</u>/cm^3[)]; and,

wherein sputter depositing a film of silicon on the substrate including a second concentration of nickel includes depositing a silicon film with an additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.

9. (Amended) The method of claim 8 wherein forming a target including silicon and a first concentration of a germanium includes forming the target with an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3[)]; and,

wherein sputter depositing a film of silicon on the substrate including a second concentration of germanium includes depositing a silicon film with an additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.

15. (Amended) The method of claim 13 wherein forming a target of single-crystal silicon including a first concentration of the first impurity includes forming a target with a first impurity selected from the group including [transistion] transition metals, phosphorous, and germanium.

17. (Amended) The method of claim 16 wherein forming a target of single-crystal silicon including a first concentration of the first impurity includes forming a target with a first concentration of nickel in the range of 0.01 to 0.5 [percentage by] atomic percent [weight] (at %); and,

wherein forming an amorphous silicon film including a second concentration of the first impurity includes forming a silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %.

18. (Amended) The method of claim 17 wherein forming a target of single-crystal silicon including a first concentration of the first impurity includes forming a target with a first concentration of nickel in the range of 0.05 to 0.2 [percentage by atomic weight (]at %[)]; and,

wherein forming an amorphous silicon film including a second concentration of the first impurity includes forming a silicon film including a second concentration of nickel in the range of 0.01 to 0.5 at %.

19. (Amended) The method of claim 17 wherein forming a target of single-crystal silicon including a first concentration of nickel includes forming a target with an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3[)]; and,

wherein forming an amorphous silicon film including a second concentration of nickel includes forming a silicon film with an additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.

22. (Amended) The method of claim 21 wherein forming a target of single-crystal silicon including a first concentration of germanium includes forming a target with an additional third concentration of phosphorous less than 5 x e^{17} [atomic weight per cubic centimeter (at] atoms/cm^3[)]; and,

wherein forming an amorphous silicon film including a second concentration of germanium includes forming a silicon film with an

additional fourth concentration of phosphorous sufficient to create a first Vth shift in the silicon film.